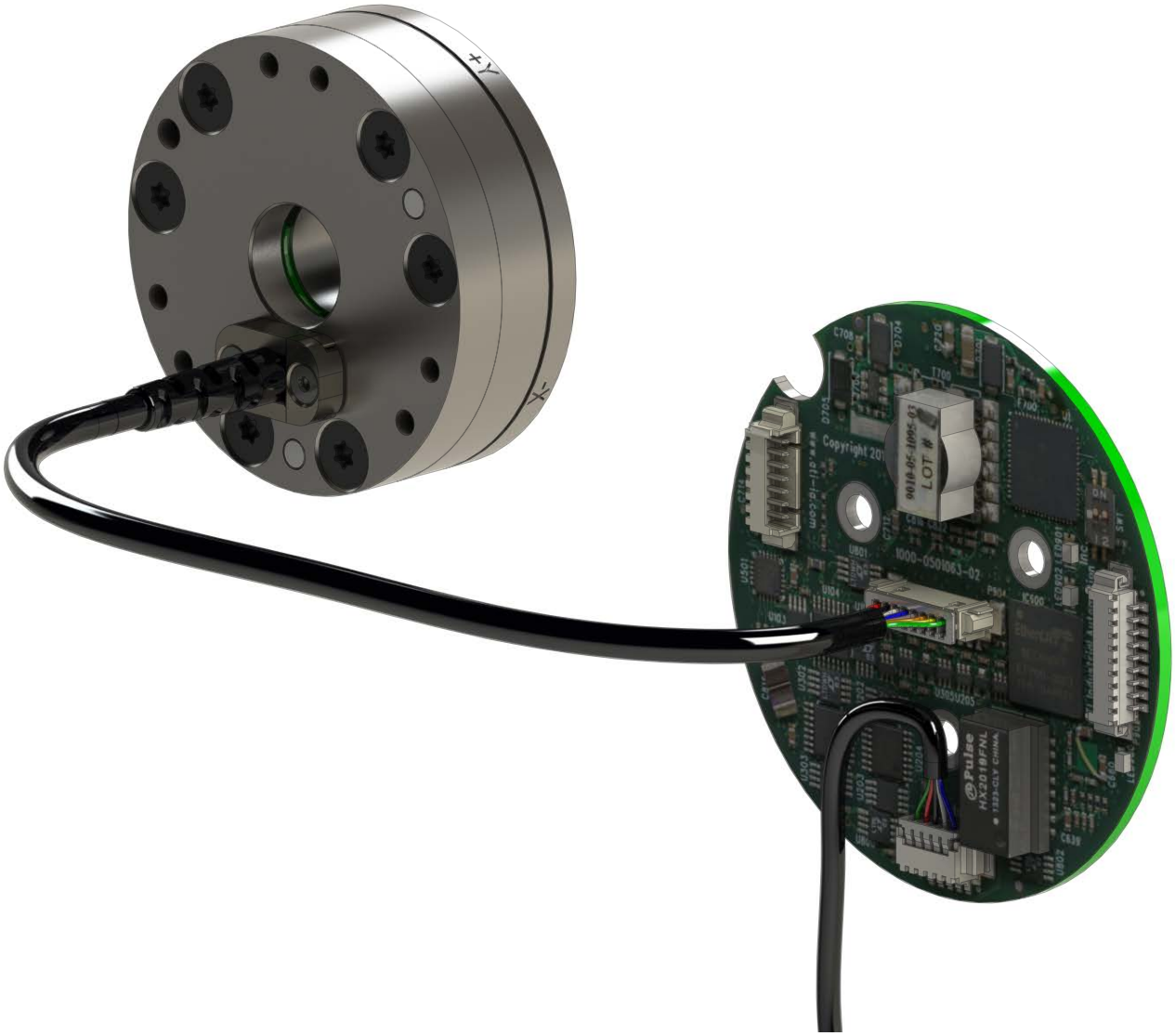
# EtherCAT F/T Interface for OEM

## Installation and Operation Manual



**Document #: 9610-05-1032**
August 2014

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> Note
>
> Please read the manual before calling customer service. Before calling, have the following information available:
>
> 1. Serial number (e.g., FT01234)
> 2. Transducer model (e.g., Nano17, Gamma, Theta, etc.)
> 3. Calibration (e.g., US-15-50, SI-65-6, etc.)
> 4. Accurate and complete description of the question or problem
> 5. Computer and software information. Operating system, PC type, drivers, application software, and other relevant information about your configuration.
>
> If possible, be near the F/T system when calling.

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# Table of Contents

**1. Safety ..... 6**
**1.1 Explanation of Notifications ..... 6**
**1.2 General Safety Guidelines ..... 6**
**1.3 Safety Precautions ..... 6**
**2. Product Overview ..... 7**
**3. Compatible Transducer ..... 8**
**4. ECATOEM Interface Board ..... 8**
**4.1 Connectors ..... 10**
4.1.1 P900 Connector for Optional 24VDC Power & Monitor Signal Interface ..... 10
4.1.2 P901 Connector for EtherCAT Interfaces ..... 11
4.1.3 P902 Connector for optional external LEDs ..... 11
4.1.4 P904 Connector for Transducer Strain Gage Signals ..... 11
**4.2 Switch ..... 12**
4.2.1 SW1 ..... 12
**4.3 LEDs ..... 12**
4.3.1 LED900 Link/Activity ..... 12
4.3.2 LED901 EtherCAT Status ..... 12
4.3.3 LED902 Board status ..... 13
**5. Operation ..... 14**
**5.1 Sample Rate ..... 14**
**5.2 Filtering ..... 14**
**5.3 Threshold Monitoring ..... 14**
**5.4 Discrete output ..... 14**
**5.5 Tool Transformation ..... 14**
**6. EtherCAT Bus Interface ..... 15**
**6.1 PDO Interface ..... 15**
**6.2 EtherCAT Dictionary Objects (SDO Data) ..... 15**
6.2.1 Object 0x2020: Tool Transformation ..... 15
6.2.2 Object 0x2040: Calibration ..... 16
6.2.3 Object 0x2060: Monitor Condition ..... 18
6.2.4 Object 0x2080: Diagnostic readings ..... 18
6.2.5 Object 0x2090: Version ..... 19
6.2.6 Object 0x6000: Reading Data ..... 19
6.2.7 Object 0x6010: Status Code ..... 20
6.2.8 Object 0x6020: Sample Counter ..... 21
6.2.9 Object 0x7010: Control Codes ..... 21

**7. Hardware Installation ..... 22**
**7.1 Chassis Grounding ..... 22**
**7.2 Transducer Handling ..... 22**
**7.3 Ground and cable shield considerations ..... 22**
**7.4 Power Supply Considerations ..... 22**
**7.5 Installation ..... 23**
**8. Troubleshooting ..... 24**
**8.1 Questions and Answers ..... 24**
8.1.1 Errors with Force and Torque Readings ..... 24
**9. Specifications ..... 25**
**9.1 Storage and Operating Conditions ..... 25**
**9.2 Electrical Specifications ..... 25**
**9.3 Weights and Dimensions ..... 25**
**10. Drawings ..... 26**
**11. Terms and Conditions of Sale ..... 27**

# Glossary of Terms

| Term | Definition |
|---|---|
| CoE | CANopen over EtherCAT, the preferred embedded protocol for configuring EtherCAT devices. Used within SDO to encode the configuration data. |
| DINT | A data type representing an unsigned integer with 32 bits. |
| E-Exit | ATI's E-Exit transducers have a cable with an over-molded strain relief. |
| EtherCAT | An industrial automation fieldbus. |
| FoE | File access over EtherCAT, the preferred embedded protocol for uploading new firmware to EtherCAT devices. |
| F/T | Force/Torque. |
| F/T Transducer | Converts force and torque into an electrical signal. |
| MAP | The Mounting Adapter Plate (MAP) is the transducer plate that attaches to the fixed surface or robot arm. |
| MOLEX PicoBlade | Product series from the connector manufacturer Molex. |
| PDO | Process Data Object, a protocol for reading and writing real-time process information cyclically. |
| PoE | Power-over-Ethernet, is a method of delivering electrical power to a PoE-compatible Ethernet device through the Ethernet cable. This simplifies installation of the Ethernet device since a separate power supply is not needed. The EtherCAT OEM F/T system is PoE compatible. |
| SDO | Service Data Object, a protocol for reading and writing configuration information acyclically. |
| STG | Strain Gage |
| TAP | Tool Adapter Plate (TAP) is the transducer surface that attaches to the load to be measured. |
| Transducer | Transducer is the component that converts the sensed load into electrical signals. |
| UDINT | A data type representing an unsigned integer with 32 bits. |
| UINT | A data type representing an unsigned integer with 16 bits. |
| USINT | A data type representing an unsigned integer with 8 bits. |

# 1. Safety

The safety section describes general safety guidelines to be followed with this product, explanation of the notification found in this manual, and safety precaution that apply to the product. More specific notification are imbedded within the sections of the manual where they apply.

## 1.1 Explanation of Notifications

The notifications included here are specific to the product(s) covered by this manual. It is expected that the user heed all notifications from the robot manufacturer and/or the manufacturers of other components used in the installation.

**DANGER:** Notification of information or instructions that if not followed will result in death or serious injury. The notification provides information about the nature of the hazardous situation, the consequences of not avoiding the hazard, and the method for avoiding the situation.

**WARNING:** Notification of information or instructions that if not followed could result in death or serious injury. The notification provides information about the nature of the hazardous situation, the consequences of not avoiding the hazard, and the method for avoiding the situation.

**CAUTION:** Notification of information or instructions that if not followed could result in moderate injury or will cause damage to equipment. The notification provides information about the nature of the hazardous situation, the consequences of not avoiding the hazard, and the method for avoiding the situation.

**NOTICE:** Notification of specific information or instructions about maintaining, operating, installation, or setup of the product that if not followed could result in damage to equipment. The notification can emphasize but is not limited to specific grease types, good operating practices, or maintenance tips.

## 1.2 General Safety Guidelines

The customer should verify that the transducer selected is rated for maximum loads and moments expected during operation. Refer to F/T Transducer Manual (9620-05-Transducer Section—Installation and Operation Manual) found in Net F/T Installation and Operation Manual (9610-05-1022) or contact ATI Industrial Automation for assistance. Particular attention should be paid to dynamic loads caused by robot acceleration and deceleration. These forces can be many times the value of static forces in high acceleration or deceleration situations.

## 1.3 Safety Precautions

**CAUTION:** Do not remove any fasteners or disassemble transducers without a removable mounting adapter plate. These include Nano, Mini, IP-rated, and some Omega transducers. This will cause irreparable damage to the transducer and void the warranty. Leave all fasteners in place and do not disassemble the transducer.

**CAUTION:** Do not probe any openings in the transducer. This will damage the instrumentation.

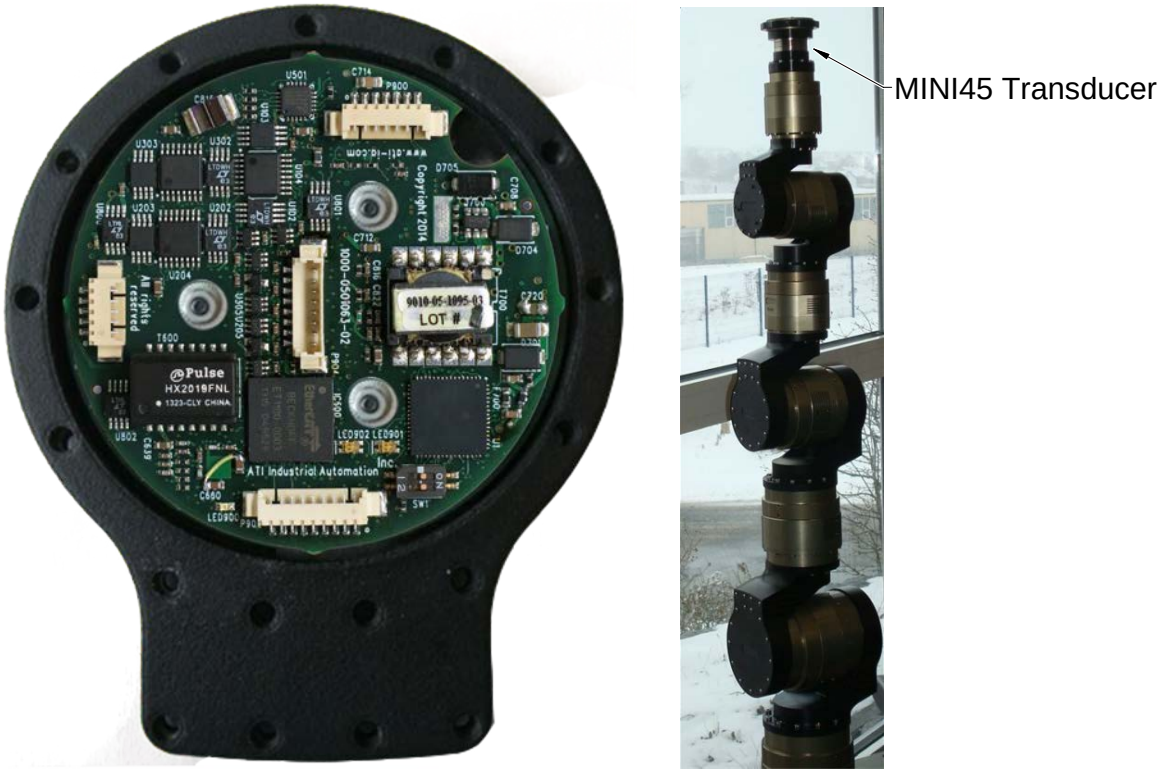
**CAUTION:** Do not exert excessive force on the transducer. The transducer is a sensitive instrument and can be damaged by applying force exceeding the single-axis overload values of the transducer and cause irreparable damage. Small Nano and Mini transducers can easily be overloaded during installation. Refer to the F/T Transducer manual (9620-05-Transducer Section) for specific transducer overload values.

# 2. Product Overview

The EtherCAT F/T Interface for OEM System consists of an ATI transducer and a F/T-to-EtherCAT interface board (ECATOEM). The transducer selected will include a Molex PicoBlade connector. The interface board is designed to be mounted within a customer's enclosure and gets supplied by customer provided 24VDC or PoE power supply.

*Figure 2.1* shows a sample application using the ECATOEM mounted in a segment of a light weight arm and a Mini45 transducer mounted on the arm.

**Figure 2.1—Sample Application**

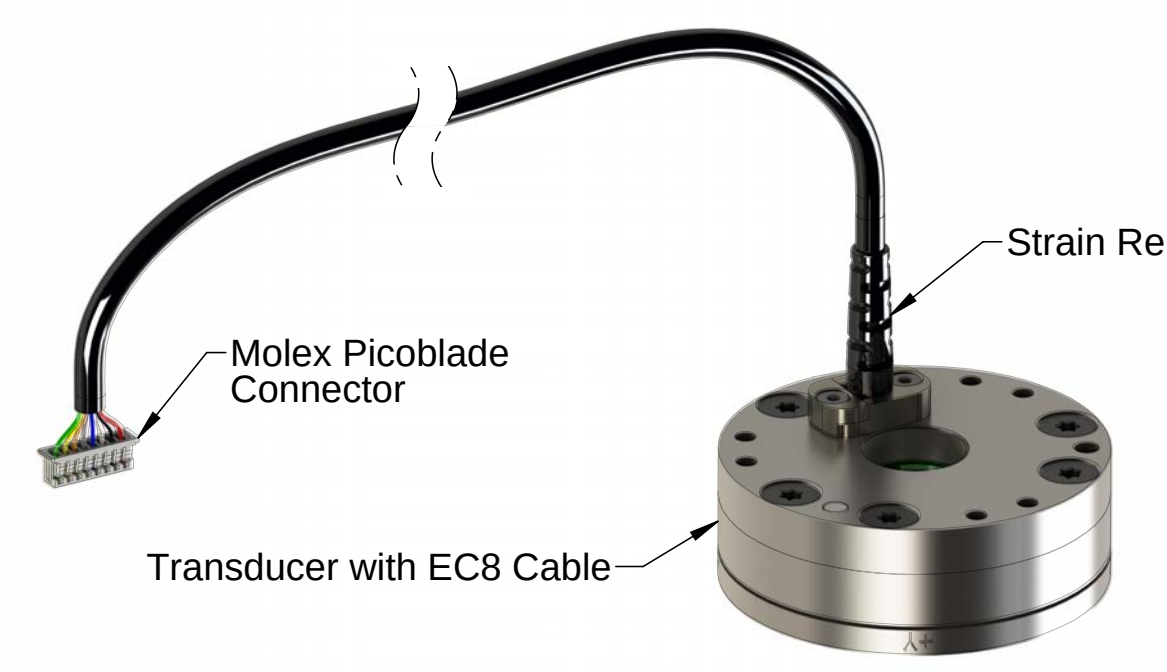


# 3. Compatible Transducer

Transducers with part numbers ending in EC8 are custom designed for use with ECATOEM. It differs from a standard Nano or Mini transducers in the following features:

- MOLEX PicoBlade connector contacts crimped to the eight wires of the transducer cable

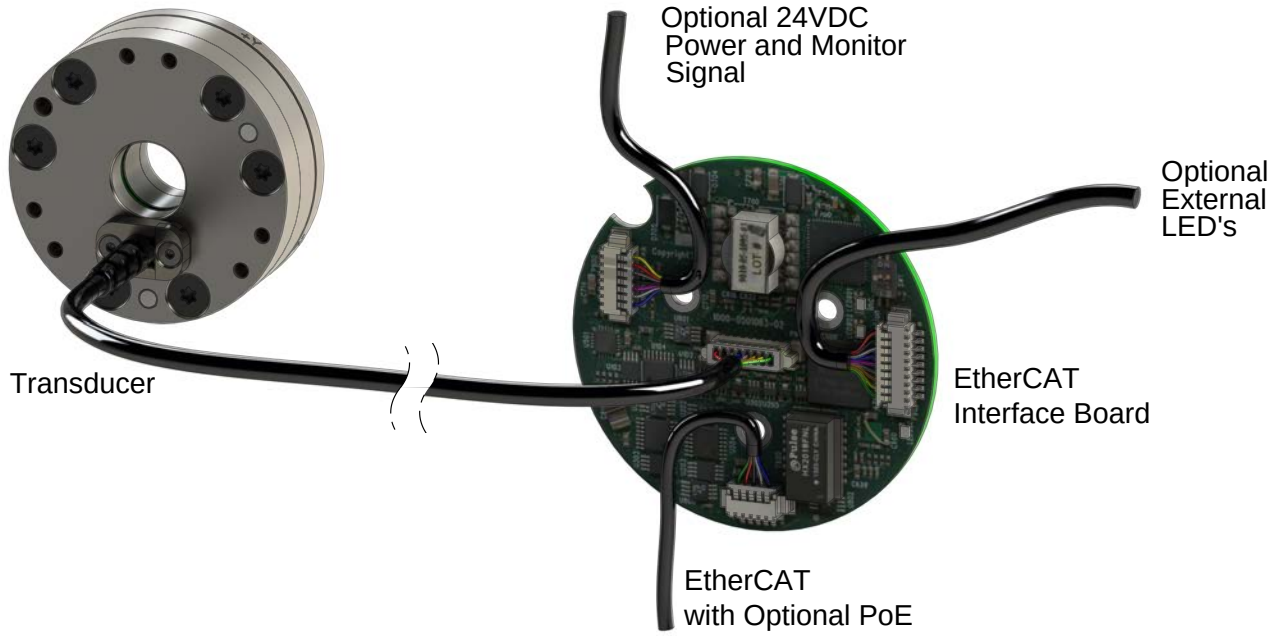
**Figure 3.1—Transducer with Strain Relieved EC8 Cable**




# 4. ECATOEM Interface Board

The ECATOEM provides an EtherCAT bus interface for ATI's TW transducers. Equipped with an 8-pin MOLEX PicoBlade connector (like the 9105-TW-MINI45-AE-0.3-EC8), they can be plugged directly into the ECATOEM interface board.

**Figure 4.1—ECATOEM System**



The 9105-ECATOEM interfaces with the transducer's strain gages via connector P903 and P904. The strain gage signals get digitized with a 16bit A/D converter, multiplied with the selected calibration matrix and the resulting force/torque data are then transmitted over an EtherCAT bus interface.

Up to 16 transducer calibrations can be stored in the on-board EEPROM.

The ECATOEM can be supplied with a DC voltage between 20V and 48V or with PoE.

**Figure 4.2—ECATOEM Block Diagram**

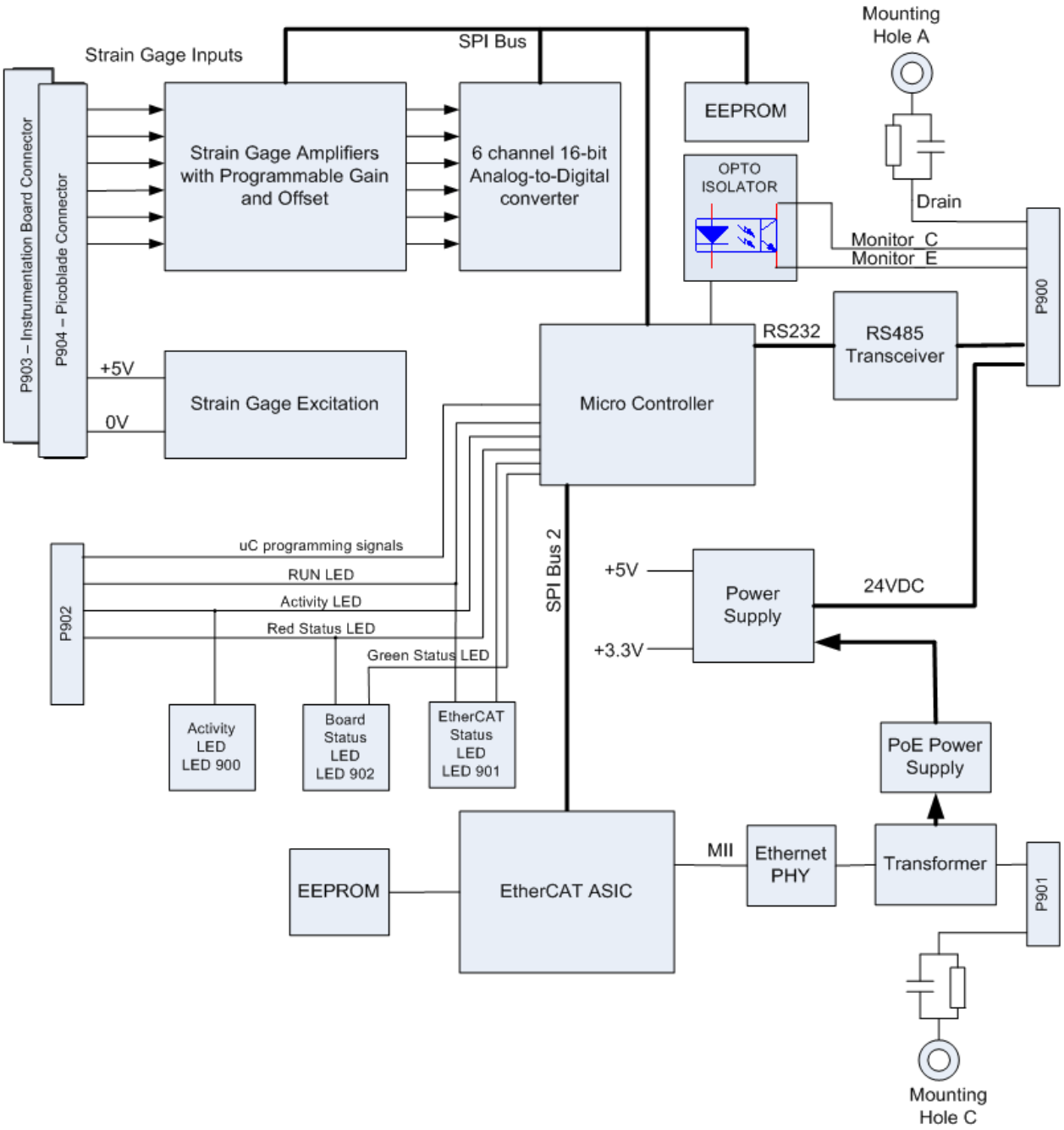
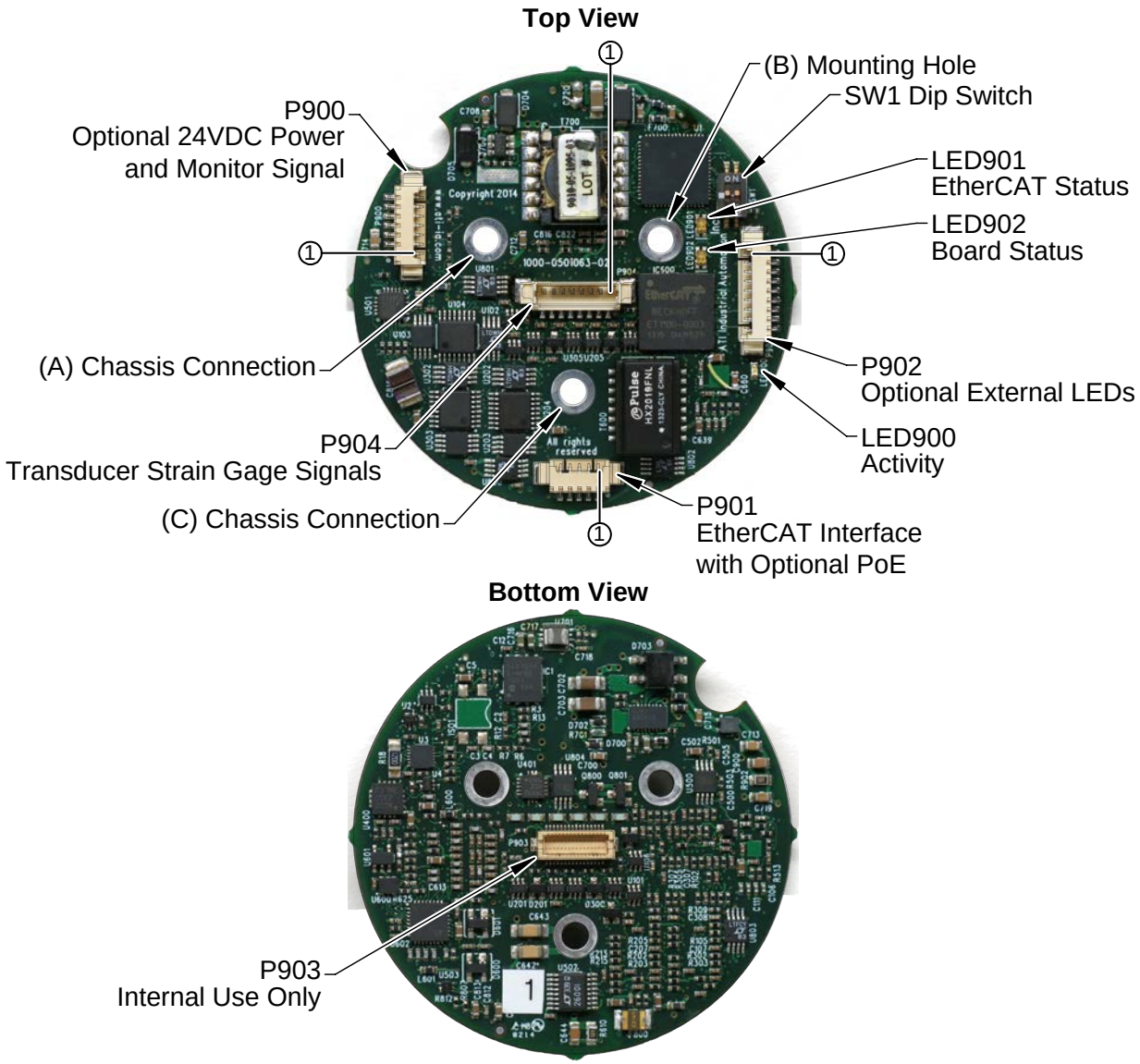


**Figure 4.3—ECATOEM – Components**




## 4.1 Connectors

The following connectors are available on the ECATOEM PCB Assembly:

### 4.1.1 P900 Connector for Optional 24VDC Power & Monitor Signal Interface

Mating connector housing: Molex 51021-0700

Mating connector contact: Molex 50058-8000

| Pin No. | Signal Name | Description |
|---|---|---|
| 1 | SL_GND | 24V Power Supply Ground |
| 2 | RS485- | - Serial Interface to NetBox |
| 3 | DRAIN | Serial Interface Shield |
| 4 | RS485+ | + Serial Interface to NetBox |
| 5 | SL_VP | 24V Power Supply Positive |
| 6 | MONITOR_E | Monitor signal: emitter contact of opto isolator |
| 7 | MONITOR_C | Monitor signal: collector contact of opto isolator |

### 4.1.2 P901 Connector for EtherCAT Interfaces

Mating connector housing: Molex 51021-0500
Mating connector contact: Molex 50058-8000

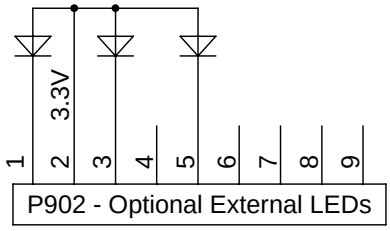
| Pin No. | Signal Name | Description |
|---|---|---|
| 1 | TX+ | Ethernet Transmit + |
| 2 | TX- | Ethernet Transmit - |
| 3 | RX+ | Ethernet Receive + |
| 4 | RX- | Ethernet Receive - |
| 5 | Shield | Ethernet cable shield |

### 4.1.3 P902 Connector for optional external LEDs

Mating connector housing: Molex 51021-0900
Mating connector contact: Molex 50058-8000

| Pin No. | Signal Name | Description |
|---|---|---|
| 1 | RUN_LED | Connect to cathode of optional external EtherCAT RUN LED |
| 2 | +3.3V | Connect to anode of optional external LEDs |
| 3 | ACTIVITY_LED | Connect to cathode of optional external ACTIVITY LED |
| 4 | +3.3V | Connect to anode of optional external LEDs |
| 5 | RED_STATUS_ LED | Connect to cathode of optional external Board Status LED |
| 6 | Reserved | For uC programming |
| 7 | Reserved | For uC programming |
| 8 | Reserved | For uC programming |
| 9 | DGND | Ground for +3.3V; used for uC programming |

**Figure 4.4—P902 LED Wiring Diagram**




### 4.1.4 P904 Connector for Transducer Strain Gage Signals

Mating connector housing: Molex 51021-0800
Mating connector contact: Molex 50058-8000

| Pin No. | Signal Name | Description |
|---|---|---|
| 1 | +VSG | 5V, Positive strain gage bridge supply voltage |
| 2 | -VSG | 0V, Negative strain gage bridge supply voltage |
| 3 | G0 | Strain gage 0 voltage |
| 4 | G1 | Strain gage 1 voltage |
| 5 | G2 | Strain gage 2 voltage |
| 6 | G3 | Strain gage 3 voltage |
| 7 | G4 | Strain gage 4 voltage |
| 8 | G5 | Strain gage 5 voltage |

## 4.2 Switch

The following switch is available on the ECATOEM PCB Assembly:

### 4.2.1 SW1

The two-position DIP switch is currently unused.

| Position | ON/OFF | Description |
|---|---|---|
| 1 | ON | **Do Not Use** |
| | OFF | Default settings OFF |
| 2 | ON | **Do Not Use** |
| | OFF | Default settings OFF |

**NOTICE:** Leave Dip switch in Default state. Changing Dip Switch settings may adversely affect the EtherCAT board functionality.

## 4.3 LEDs

The following LEDs are available on the ECATOEM PCB Assembly:

### 4.3.1 LED900 Link/Activity

One green LED signals activity on the EtherCAT port.

| LED State | Link | Activity | Condition |
|---|---|---|---|
| Off | No | No | Port closed |
| Green | Yes | No | Port open |
| Flashing Green | Yes | Yes | Port open |

### 4.3.2 LED901 EtherCAT Status

One dual-color LED signals the status of the EtherCAT Network in the following way.

| LED State | RUN State | ERROR State | Description |
|---|---|---|---|
| OFF | INIT | No | Device is in state INIT |
| GREEN Blinking | PRE-OP | No | Device is in state PRE-OPERATIONAL |
| GREEN Single Flash | SAFE-OP | No | Device is in state SAFE-OPERATIONAL |
| GREEN | OP | No | Device is in state OPERATIONAL |
| RED Double Flash | | Process Data Watchdog Timeout | An application watchdog timeout has occurred. E.g. Sync Manager Watchdog timeout |
| RED Single Flash | | Local Error | Slave device application has changed the EtherCAT state autonomously, due to local error. E.g. device changes its EtherCAT state from OP to SAFE-OP due to a synchronization error |
| RED Blinking | | Invalid Configuration Error | General configuration error.<br>E.g<br>State change commanded by master is impossible due to register or object settings, or invalid hardware configuration (pin sharing violation detected by ESC) |

### 4.3.3 LED902 Board status

One dual-color LED signals the status of the EtherCAT Board in the following way.

| LED State | Status | Description |
|---|---|---|
| OFF | No Power | The board doesn't have sufficient power |
| Green | All OK | Fully Operational, No errors |
| Orange (Amber) | Saturation | Transducer input is saturated; one of the strain gage input voltages is too high; all force and torque data are invalid; use less sensitive calibration if available; |
| Red | Diagnostic voltage error | One of the internal diagnostic voltages is outside the acceptable range; |
| Red Blinking (1Hz) | No calibration loaded | Active calibration slot is empty or has checksum error; |
| Red Blinking (10Hz) | communication error with ECAT ASIC | No or faulty communication between uC and EtherCAT ASIC |

# 5. Operation

## 5.1 Sample Rate

The firmware samples internally at 3000 Hz.

## 5.2 Filtering

The "Filter Selection" field in *Section 6.2.9—Object 0x7010: Control Codes* controls the coefficient used in the internal IIR filter. The cutoff frequency is dependent on the internal sample rate, which is defined in *Section 5.1—Sample Rate*. The relative cutoff frequencies for different values of this coefficient are:

| Coefficient | Cutoff Frequency (Percent of Internal Sample Rate) | Frequency |
|---|---|---|
| 0 | No filter | N/A |
| 1 | 11.97% | 360 Hz |
| 2 | 4.66% | 140 Hz |
| 3 | 2.17% | 64 Hz |
| 4 | 1.04% | 32 Hz |
| 5 | 0.51% | 16 Hz |
| 6 | 0.26% | 8 Hz |
| 7 | 0.12% | 4 Hz |
| 8 | 0.07% | 2 Hz |

## 5.3 Threshold Monitoring

The EtherCAT OEM FT system will allow the user to configure thresholds. To activate a threshold, first write the appropriate values in *Section 6.2.3—Object 0x2060: Monitor Condition*, then set the bit corresponding to that threshold in the "Monitor Condition Enable Bitmap" in *Section 6.2.9—Object 0x7010: Control Codes*.

The software currently supports one monitor condition.

## 5.4 Discrete output

The discrete output will turn on whenever any active monitor condition becomes true. The user can also configure it to turn on whenever any error bit becomes true (this is not yet available in the beta software).

## 5.5 Tool Transformation

To activate a tool transformation, first write the appropriate transform coefficients to *Section 6.2.1—Object 0x2020: Tool Transformation*, then set the "Tool Transform Index Selection" bits in *Section 6.2.9—Object 0x7010: Control Codes* to activate that condition. The software currently only supports one tool transformation.

# 6. EtherCAT Bus Interface

The EtherCAT bus interface allows a user to:

- Determine which calibration is active
- Select a calibration to be active
- Read the active calibration information matrix, serial number, etc.
- Read the firmware revision of the ECATOEM
- Read force/torque data
- Read strain gage data and status information.
- Configure tool transformation.
- Set monitor conditions
- Set low pass filter cutoff frequency.
- Bias transducer.

## 6.1 PDO Interface

The PDO interface is used to exchange data in real-time with the F/T sensor.

a. a. TxPDO Map / Output Data
The TxPDO combines *Object 0x6000: Reading Data*, *Object 0x6010: Status Code*, and *Object 0x6020: Sample Counter*.

b. b. RxPDO Map / Input Data
The RxPDO map consists of *Object 0x7010: Control Codes*.

## 6.2 EtherCAT Dictionary Objects (SDO Data)

The SDO data is used to configure the sensor and read manufacturing and calibration information. This section documents dictionary objects that are specific to the EtherCAT F/T sensor application; it does not list objects which are a required part of the EtherCAT standard.

### 6.2.1 Object 0x2020: Tool Transformation

This writable object contains the following 32-bit signed integer fields:

| Subindex | Name | Description |
|---|---|---|
| 0x01 | Rx | The rotation about the X axis, in units of 0.1 degrees, e.g. an Rx value of 900 = 90 degrees. |
| 0x02 | Ry | The rotation about the Y axis, in units of 0.1 degrees. |
| 0x03 | Rz | The rotation about the Z axis, in units of 0.1 degrees. |
| 0x04 | Dx | The displacement along the x axis, in units of 0.01 calibration length units. E.g. if the distance component of the torque is meters, a Dx value of 100 = 1 meter. |
| 0x05 | Dy | The displacement along the y axis, in units of 0.01 calibration length units. |
| 0x06 | Dz | The displacement along the z axis, in units of 0.01 calibration length units. |

### 6.2.2 Object 0x2040: Calibration

This read-only object contains information about the currently active calibration selected by the "Calibration Selection" field in *Section 6.2.9—Object 0x7010: Control Codes*. It contains the following fields:

| Subindex | Name | Type | Description |
|---|---|---|---|
| 0x01 | FT Serial | STRING(8) | The FT Serial Number, e.g. "FT01234." |
| 0x02 | Calibration Part Number | STRING(30) | The calibration part number e.g. "SI-120-95." |
| 0x03 | Calibration Family | STRING(8) | Always reads "ECAT" |
| 0x04 | Calibration Time | STRING(30) | The date the sensor was calibrated |
| 0x05 | Matrix FxG0 | DINT | These 36 elements contain the scaled "working" matrix used for this calibration. This will not necessarily match the calibration matrix in the calibration file, because the calibration matrix has to be scaled to suitably large integers before it can be used by the sensor. |
| 0x06 | Matrix FxG1 | | |
| 0x07 | Matrix FxG2 | | |
| 0x08 | Matrix FxG3 | | |
| 0x09 | Matrix FxG4 | | |
| 0x0a | Matrix FxG5 | | |
| 0x0b | Matrix FyG0 | | |
| 0x0c | Matrix FyG1 | | |
| 0x0d | Matrix FyG2 | | |
| 0x0e | Matrix FyG3 | | |
| 0x0f | Matrix FyG4 | | |
| 0x10 | Matrix FyG5 | | |
| 0x11 | Matrix FzG0 | | |
| 0x12 | Matrix FzG1 | | |
| 0x13 | Matrix FzG2 | | |
| 0x14 | Matrix FzG3 | | |
| 0x15 | Matrix FzG4 | | |
| 0x16 | Matrix FzG5 | | |
| 0x17 | Matrix TxG0 | | |
| 0x18 | Matrix TxG1 | | |
| 0x19 | Matrix TxG2 | | |
| 0x1a | Matrix TxG3 | | |
| 0x1b | Matrix TxG4 | | |
| 0x1c | Matrix TxG5 | | |
| 0x1d | Matrix TyG0 | | |
| 0x1e | Matrix TyG1 | | |
| 0x1f | Matrix TyG2 | | |
| 0x20 | Matrix TyG3 | | |
| 0x21 | Matrix TyG4 | | |
| 0x22 | Matrix TyG5 | | |
| 0x23 | Matrix TzG0 | | |
| 0x24 | Matrix TyG1 | | |
| 0x25 | Matrix TyG2 | | |
| 0x26 | Matrix TyG3 | | |
| 0x27 | Matrix TyG4 | | |
| 0x28 | Matrix TyG5 | | |

| Subindex | Name | Type | Description | |
|---|---|---|---|---|
| 0x29 | Force Units | USINT | Value | Unit |
| | | | 0x2a | Lbf |
| | | | 1 | N |
| | | | 2 | Klbf |
| | | | 3 | kN |
| | | | 4 | Kg |
| 0x2a | Torque Units | USINT | Value | Unit |
| | | | 0 | Lbf-in |
| | | | 1 | Lbf-ft |
| | | | 2 | N-m |
| | | | 3 | N-mm |
| | | | 4 | Kg-cm |
| | | | 5 | kN-m |
| 0x2b | Max Fx Counts | DINT | The maximum rated value for this axis, in counts.[1] | |
| 0x2c | Max Fy Counts | | | |
| 0x2d | Max Fz Counts | | | |
| 0x2e | Max Tx Counts | | | |
| 0x2f | Max Ty Counts | | | |
| 0x30 | Max Tz Counts | | | |
| 0x31 | Counts Per Force | DINT | The calibration counts per force unit.1 | |
| 0x32 | Counts Per Torque | DINT | The calibration counts per torque unit.[1] | |
| 0x33 | Gain G0 | UINT16 | The code used to program the gain potentiometer | |
| 0x34 | Gain G1 | | | |
| 0x35 | Gain G2 | | | |
| 0x36 | Gain G3 | | | |
| 0x37 | Gain G4 | | | |
| 0x38 | Gain G5 | | | |
| 0x39 | Offset G0 | UINT16 | The code used to program the offset DAC. | |
| 0x3a | Offset G1 | | | |
| 0x3b | Offset G2 | | | |
| 0x3c | Offset G3 | | | |
| 0x3d | Offset G4 | | | |
| 0x3e | Offset G5 | | | |

Note:

1. In the beta version of the software, divide these values by 16 to get the actual counts that will be used in the EtherCAT interface.

### 6.2.3 Object 0x2060: Monitor Condition

This user-writable object allows the user to configure an axis, a threshold value, and direction to continuously evaluate against the current F/T data. When an enabled condition becomes true, the monitor output becomes active and stays active until reset via setting the "Reset Monitor Condition" bit in *Section 6.2.9—Object 0x7010: Control Codes*, which is also mapped into the TxPDO data.

The following fields are available in the monitor condition:

| Subindex | Name | Type | Description | |
|---|---|---|---|---|
| 0x01 | Threshold Value | DINT | The threshold value to compare against, in counts. | |
| 0x02 | Axis | USINT | **Value** | **Axis** |
| | | | 0x03 | Fx |
| | | | 1 | Fy |
| | | | 2 | Fz |
| | | | 3 | Tx |
| | | | 4 | Ty |
| | | | 5 | Tz |
| 0x03 | CompareGreaterThan | BOOL | If TRUE, the monitor condition is true when the selected axis is greater than the selected threshold value. If FALSE, the monitor condition is true when the selected axis is less than the selected threshold value. | |

### 6.2.4 Object 0x2080: Diagnostic readings

This read-only object provides access to diagnostic values. These values may be useful when troubleshooting the system. All diagnostic voltages are filtered with the filter coefficient set to "8" – see *Section 5.2—Filtering* for details.

The following fields are available in the Diagnostic Readings object:

| Subindex | Name | Type | Description | Limits | Sampling Rate |
|---|---|---|---|---|---|
| 0x01 | 6V Supply Sense | UINT16 | The 6V supply ADC reading. | 2568 to 3970 counts | ½ strain gage sampling rate.[1] |
| 0x02 | Thermistor | UINT16 | The thermistor ADC reading. | None, information only. | ½ strain gage sample rate. [1] |
| 0x03 | VBridge Volts | INT16 | The excitation voltage ADC reading. | 17050 to 17750 counts. | Strain gage sampling rate.[1] |
| 0x04 | VBridge Current | INT16 | The excitation current ADC reading. | 500 to 6554 counts. | Strain gage sampling rate.[1] |

Note:
1. See *Section 5.1—Sample Rate* for strain gage sampling rate.

### 6.2.5 Object 0x2090: Version

This read-only object provides firmware version information.

The following fields are available in the version object:

| Subindex | Name | Type | Description |
|---|---|---|---|
| 0x01 | Major | UINT16 | Major Version |
| 0x02 | Minor | UINT16 | Minor Version |
| 0x03 | Revision | UINT16 | Revision |

### 6.2.6 Object 0x6000: Reading Data

This read-only object represents the current force/torque or gage data. It is mapped into the TxPDO input data.

The following fields are present in the reading data:

| Subindex | Name | Type | Description |
|---|---|---|---|
| 0x01 | Fx/Gage0 | DINT | If the “Gage Data” bit in *Section 6.2.9—Object 0x7010: Control Codes* is set, these fields contain the 16-bit gage data. If the “Gage Data” bit is cleared, these fields contain the 32-bit F/T result data, in counts. |
| 0x02 | Fy/Gage1 | | |
| 0x03 | Fz/Gage2 | | |
| 0x04 | Tx/Gage3 | | |
| 0x05 | Ty/Gage4 | | |
| 0x06 | Tz/Gage5 | | |

### 6.2.7 Object 0x6010: Status Code

This object contains a single DINT value (at subindex 0), with the following bitmap:

| Bit Number | Description | Indicates Error? |
|---|---|---|
| 0 | Monitor Condition Tripped: This bit becomes active when an active monitor condition becomes true, and remains set until cleared with the "Reset Monitor Conditions" bit in *Section 6.2.9—Object 0x7010: Control Codes*. | No |
| 1 | Supply Out of Range: This bit becomes active if the supply sense reading in *Section 6.2.4—Object 0x2080: Diagnostic readings* is out of the expected range. This bit remains set until power cycle. It may indicate a system fault. | Yes |
| 2 | Reserved | |
| 3 | VBridge Volts Out of Range: This bit is set if the excitation voltage in *Section 6.2.4—Object 0x2080: Diagnostic readings* is out of the expected range. This bit remains set until power cycle. It may indicate a system fault. | Yes |
| 4 | VBridge Current Out of Range: This bit is set if the excitation current in *Section 6.2.4—Object 0x2080: Diagnostic readings* is out of the expected range. This bit remains set until power cycle. It may indicate a system fault. | Yes. |
| 5 | DPOT Fault. This bit is set if there is an error reading back the value written to a DPOT. It remains set until power cycle. | Yes. |
| 6 | EEPROM Fault. This bit is set if there is an error reading back the value written to EEPROM. It remains set until power cycle. | Yes. |
| 7 | DAC Fault. This bit is set if there is an error detected communicating with the DAC. The DAC used (LTC2600) does not support a read-back operation, but it does support daisy-chaining, so the firmware detects a failure by prepending a known value to any commands, and looking for an echo of that known value on the SPI input after sending the command. It remains set until power cycle. | Yes. |
| 6-27 | Reserved | |
| 28 | Simulated Error. This bit mirrors the "Simulated Error Control" bit in *Section 6.2.9—Object 0x7010: Control Codes*. | No, but can be used to test user error handling if treated as such. |
| 29 | Calibration checksum error. This bit is set if the active calibration did not have a valid checksum when read from EEPROM. | Yes. |
| 30 | Saturation. This bit is set whenever a strain gage sample is saturated, and stays high for 32 samples after the last saturated sample, to allow time for the saturated sample's effect on the filtered data to abate. | Yes. |
| 31 | Error: This bit is set whenever any status code bit that indicates an error is set. | Yes |

### 6.2.8 Object 0x6020: Sample Counter

This object contains a single 32-bit unsigned integer at subindex 0 that increments each time an F/T sample (one complete set of gage data) is read.

### 6.2.9 Object 0x7010: Control Codes

This object is mapped into the RxPDO for real-time control of the F/T system. It contains the following fields:

| Subindex | Name | Type | Description | |
|---|---|---|---|---|
| 0x01 | Control 1 | DINT | **Bit** | **Function** |
| | | | 0 | 1 = Set bias against current load.<br>0 = Use last set bias. |
| | | | 1 | 1 = Select gage output<br>0 = Select F/T output. |
| | | | 2 | 1 = Set test error<br>0 = clear test error |
| | | | 3 | 1 = Clear monitor condition status.<br>0 = Leave monitor condition status as-is. |
| | | | 4-7 | Filter selection |
| | | | 8-11 | Calibration Selection |
| | | | 12-31 | Reserved |
| 0x02 | Control 2 | DINT | **Bit** | **Function** |
| | | | 0-15 | Monitor condition enable bitmap |
| | | | 16-19 | Tool transform index selection. |
| | | | 20-30 | Reserved |
| | | | 31 | Simulated Error Control |

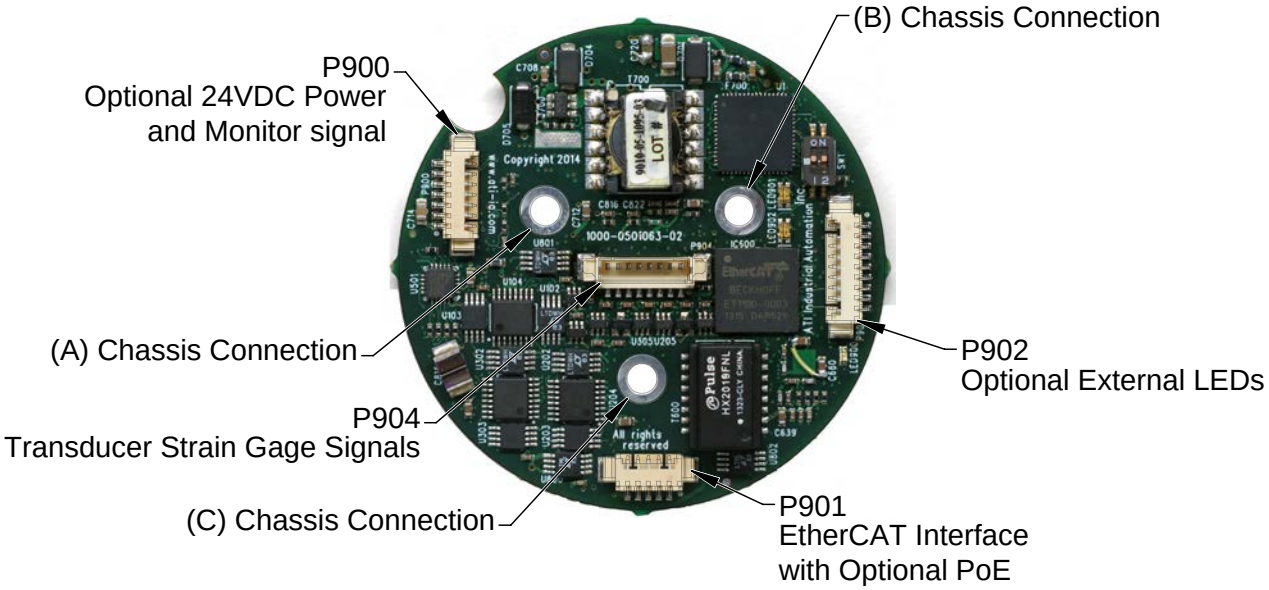
# 7. Hardware Installation

The following section provides information for installing the ECATOEM PCB into an application.

## 7.1 Chassis Grounding

The ECATOEM interface board provides three mounting holes. One of these (marked “C” in *Figure 7.1*) provides a path to the shield connection of the EtherCAT bus cable. The mounting hole (marked “A” in the picture below) provides a path to the shield connection of the 24VDC power and monitor signal cable. For best EMI performance both, “A” and “C” should get connected to chassis ground.

**Figure 7.1—ECATOEM Interface Board Mounting**




**NOTICE:** To minimize PCB vibration, all three mounting holes should be used.

## 7.2 Transducer Handling

In addition to the standard transducer handling instructions (see Manual 9620-05-Transducer Section for details), the following should be observed:

- The transducer calibration label FTxxxx must not be removed or painted over. If a transducer gets returned to ATI for calibration or repair, it is important that this number is present.
- The transducer connector has no strain relief. To protect the fragile crimp contacts it is important to provide a suitable strain relief in the final product.

## 7.3 Ground and cable shield considerations

There are several options for connecting the transducer cable shield:

1. If the transducer is connected to chassis ground, then don’t connect the cable shield (since the shield is connected to the transducer body and such to chassis ground).
2. If the transducer is isolated, then:
    a. Connect the cable shield to chassis ground or
    b. Connect the cable shield to system Ground P900 Pin 9

You may have to experiment to find the best solution for EMC compliance and best noise performance.

## 7.4 Power Supply Considerations

The ECATOEM interface board can be supplied with a DC voltage between 20V and 48 V on P902 or with Power-over-Ethernet through the EtherCAT interfcae (P901)

## 7.5 Installation

The transducer can be used in a variety of applications that will affect how best to route the cable and determine the proper bending radius to use. Some applications will allow the transducer and the cable to remain in a static condition, other applications require the transducer to be in a dynamic condition that requires the cable to be subjected to repetitive motion. It is important not to expose the transducer cable connectors to this repetitive motion, and properly restrain the cable close to the transducer connection. Refer to the Transducer Section Manual (*http://www.ati-ia.com/app_content/documents/9620-05-Transducer%20Section.pdf*) for proper cable bending radius and cable restraint methods.

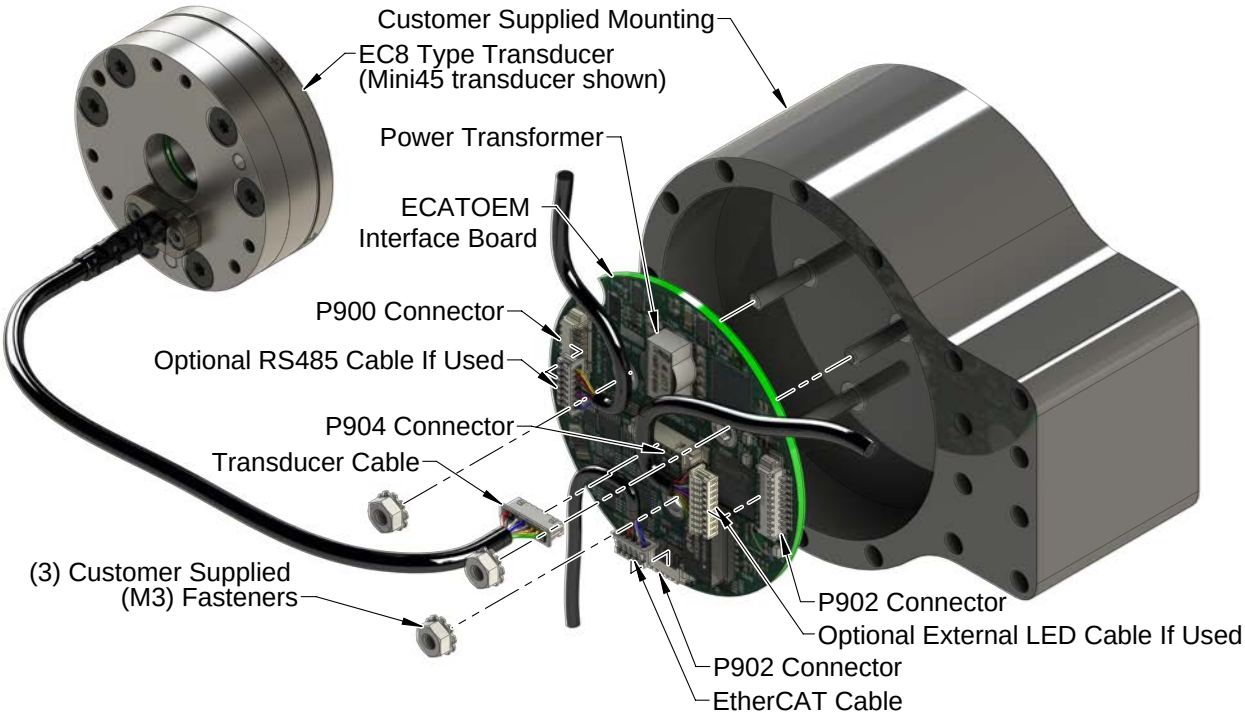
1. Attach the ECATOEM interface board to the mounting using customer supplied M3 fasteners, use all three mounting holes to secure the board. Refer to *Figure 7.2.*

**NOTICE:** Make sure mounting holes "A" and "C" are connected to chassis ground. Not connecting the "A" and "C" mounting holes to chassis ground may cause unpredictable behavior. Refer to *Figure 7.1*

2. Route and connect the EtherCAT cable to the P901 connector on the ECATOEM interface board.
3. Route and connect the Transducer cable to the P904 connector on the ECATOEM interface board.

**NOTICE:** Make sure to route the Transducer cable away from the Power Transformer on the ECATOEM interface board. Routing the Transducer cable close to the power transformer can cause noise problems.

**Figure 7.2—ECATOEM Interface Board Installation**




4. If using an external DC power supply instead of PoE then connect the 24VDC power (Pin 1(-) and Pin 5 (+)) to P900 connector on the ECATOEM interface board. Refer to *Section 4.1.1—P900 Connector for Optional 24VDC Power & Monitor Signal Interface* for P900 connector signals.
5. If using the Optional External LED cable route the cable and connect to the P902 connector on the ECATOEM interface board. Refer to *Section 4.1.3—P902 Connector for optional external LEDs* for P902 connector signals.

# 8. Troubleshooting

This section includes answers to some issues that might arise when setting up and using the ECATOEM system. The question or problem is listed followed by its probable answer or solution. They are categorized for easy reference.

The information in this section should answer many questions that might arise in the field. Customer service is available to users who have problems or questions addressed in the manuals.

**ATI Industrial Automation**
**Attn: F/T Customer Service**
Pinnacle Park
1031 Goodworth Drive
Apex, NC 27539 USA

Phone: +1.919.772.0115
Fax:+1.919.772.8259
Email: *ft_support@ati-ia.com*

**NOTICE:** Please read the F/T manuals before calling customer service. When calling, have the following information available:

1. Serial number(s)
2. Transducer type (e.g., Nano17, Gamma, Theta)
3. Calibration (e.g., US-15-50, SI-130-10)
4. An accurate and complete description of the question or problem.
5. If possible all information that is displayed on Net F/T page System Info (manuf.htm). The ECATOEM has to be connected to a NetBox to access the System Info.

If possible, the F/T system should be accessible when talking with an ATI Industrial Automation customer service representative.

## 8.1 Questions and Answers

### 8.1.1 Errors with Force and Torque Readings

Bad data from the transducer's strain gages can cause errors in force/torque readings. These errors can result in problems with transducer biasing and accuracy. Listed below are the basic conditions of bad data. Use this to troubleshoot your problem.

| Question/Problem | Answer/Solution |
|---|---|
| Noise | Jumps in raw strain gage readings (with transducer unloaded) greater than 80 counts is considered abnormal. Noise can be caused by mechanical vibrations and electrical disturbances, possibly from a poor ground. It can also indicate component failure within the system. Make sure that the DC supply voltage for the ECATOEM has little to no noise superimposed. |
| Drift | After a load is removed or applied, the raw gage reading does not stabilize, but continues to increase or decrease. This may be observed more easily in resolved data mode using the bias command. Drift is caused by temperature change, mechanical coupling, or internal failure. Mechanical coupling is caused when a physical connection is made between the tool plate and the transducer body (i.e., filings between the tool adapter plate and the transducer body). Some mechanical coupling is common, such as hoses and wires attached to a tool. |
| Hysteresis | When the transducer is loaded and then unloaded, gage readings do not return quickly and completely to their original readings. Hysteresis is caused by mechanical coupling (explained in Drift section) or internal failure. |

# 9. Specifications

## 9.1 Storage and Operating Conditions

| Table 9.1—Temperature | | |
|---|---|---|
| **Component** | **Storage Temperature, °C** | **Operating Temperature, °C** |
| ECATOEM | -40 to +100 | -20 to +70 |
| 9105-MINI45TH12-AE-0.40-EC8 | See Transducer Section Manual *http://www.ati-ia.com/app_content/documents/9620-05-Transducer%20Section.pdf* | See Transducer Section Manual *http://www.ati-ia.com/app_content/documents/9620-05-Transducer%20Section.pdf* |

## 9.2 Electrical Specifications

| Table 9.2—Power Supply | | |
|---|---|---|
| **Power Source†** | **Voltage** | **Maximum Power Consumption[1]** |
| DCIN through P900 | (20V min. to 48V max.) | 3.0W |

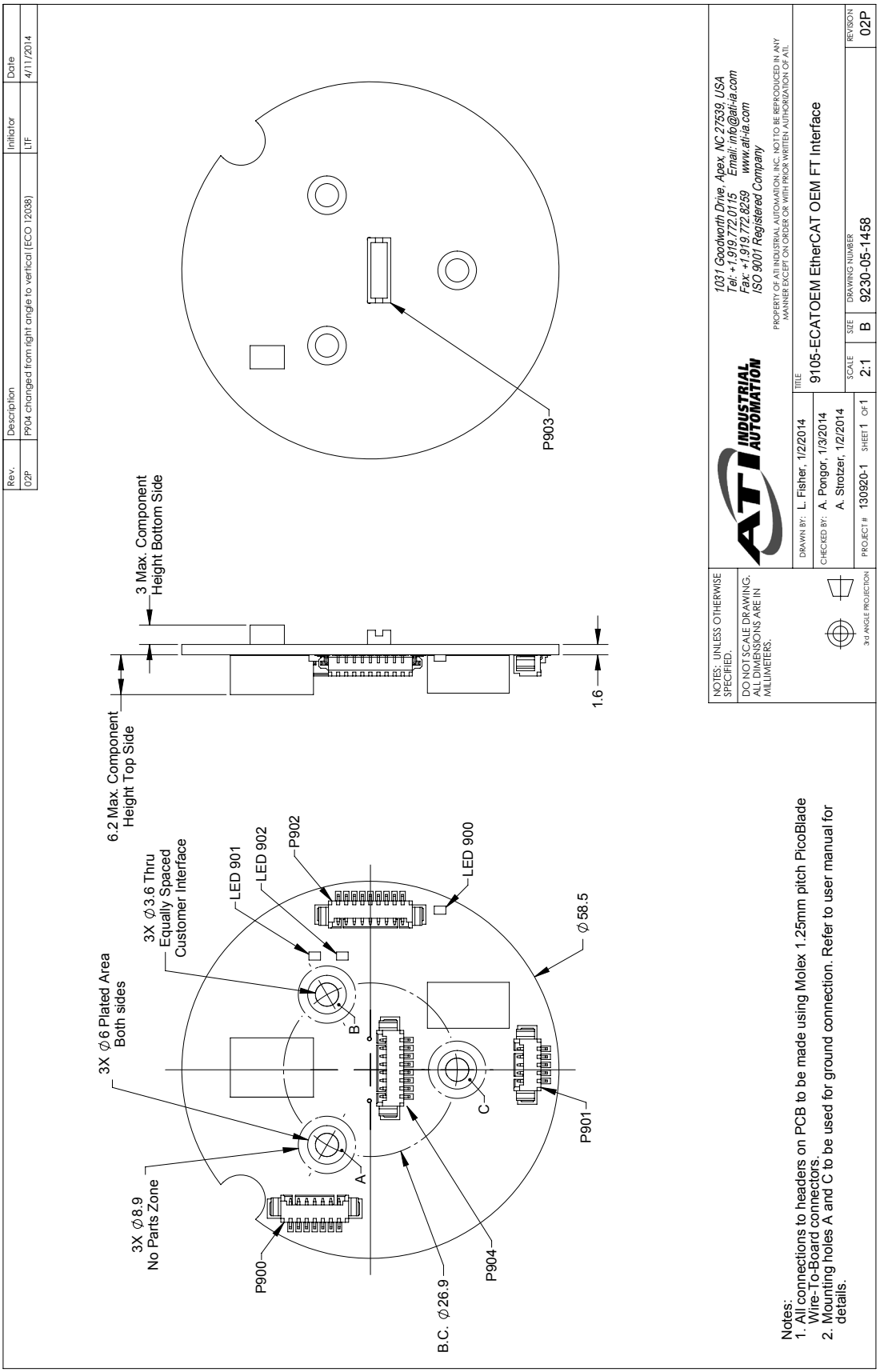
Notes:
1. With Mini45 transducer connected to the ECATOEM interface board Assembly.

The ECATOEM power supply input is protected against wrong polarity.

## 9.3 Weights and Dimensions

| Table 9.3—Weights and Dimensions | | |
|---|---|---|
| **Component** | **Weight (approx.)** | **Dimensions** |
| ECATOEM PCB Assembly | 17g (0.6oz) | See drawing in Section 11.1 |
| 9105-TW-MINI45-AE-0.3-EC8 | See Transducer Section Manual *http://www.ati-ia.com/app_content/documents/9620-05-Transducer%20Section.pdf* | See Transducer Section Manual *http://www.ati-ia.com/app_content/documents/9620-05-Transducer%20Section.pdf* |

# 10. Drawings


Rev.
Description
Initiator
Date
02P
P904 changed from right angle to vertical (ECO 12038)
LTF
4/11/2014
P903
3 Max. Component Height Bottom Side
1.6
6.2 Max. Component Height Top Side
3X ⌀3.6 Thru Equally Spaced Customer Interface
LED 901
LED 902
P902
LED 900
⌀58.5
3X ⌀6 Plated Area Both sides
B
C
A
P901
3X ⌀8.9 No Parts Zone
P900
P904
B.C. ⌀26.9
NOTES: UNLESS OTHERWISE SPECIFIED.
DO NOT SCALE DRAWING. ALL DIMENSIONS ARE IN MILLIMETERS.
3rd ANGLE PROJECTION
DRAWN BY: L. Fisher, 1/2/2014
CHECKED BY: A. Pongor, 1/3/2014
A. Strotzer, 1/2/2014
PROJECT # 130920-1 SHEET 1 OF 1
TITLE
9105-ECATOEM EtherCAT OEM FT Interface
SCALE 2:1
SIZE B
DRAWING NUMBER 9230-05-1458
REVISION 02P
1031 Goodworth Drive, Apex, NC 27539, USA
Tel: +1.919.772.0115 Email: info@ati-ia.com
Fax: +1.919.772.8259 www.ati-ia.com
ISO 9001 Registered Company
PROPERTY OF ATI INDUSTRIAL AUTOMATION, INC. NOT TO BE REPRODUCED IN ANY MANNER EXCEPT ON ORDER OR WITH PRIOR WRITTEN AUTHORIZATION OF ATI.
Notes:
1. All connections to headers on PCB to be made using Molex 1.25mm pitch PicoBlade Wire-To-Board connectors.
2. Mounting holes A and C to be used for ground connection. Refer to user manual for details.

# 11. Terms and Conditions of Sale

The following Terms and Conditions are a supplement to and include a portion of ATI's Standard Terms and Conditions, which are on file at ATI and available upon request.

ATI warrants to Purchaser that force torque sensor products purchased hereunder will be free from defects in material and workmanship under normal use for a period of one year from the date of shipment. This warranty does not cover components subject to wear and tear under normal usage or those requiring periodic replacement. ATI will have no liability under this warranty unless: (a) ATI is given written notice of the claimed defect and a description thereof with thirty (30) days after Purchaser discovers the defect and in any event, not later than the last day of the warranty period and (b) the defective item is received by ATI not later than (10) days after the last day of the warranty period. ATI's entire liability and Purchaser's sole remedy under this warranty is limited to repair or replacement, at ATI's election, of the defective part or item or, at ATI's election, refund of the price paid for the item. The foregoing warranty does not apply to any defect or failure resulting from improper installation, operation, maintenance, or repair by anyone other than ATI.

ATI will in no event be liable for incidental, consequential, or special damages of any kind, even if TI has been advised of the possibility of such damages. ATI's aggregate liability will in no event exceed the amount paid by the purchaser for the item which is the subject of claim or dispute. ATI will have no liability of any kind for failure of any equipment or other items not supplied by ATI.

No action against ATI, regardless of form, arising out of or in any way connected with products or services supplied hereunder, may be brought more than one year after the cause of action accrued.

No representation or agreement varying or extending the warranty and limitation of remedy provisions contained herein is authorized by ATI, and may not be relied upon as having been authorized by ATI, unless in writing and signed by an executive officer of ATI.

Unless otherwise agreed in writing by ATI, all designs, drawings, data, inventions, software, and other technology made or developed by ATI in the course of providing products and services hereunder, and all rights therein under any patent, copyright, or other law protecting intellectual property, shall be and remain ATI's property. The sale of products or services hereunder does not convey any expressed or implied license under any patent, copyright, or other intellectual property right owned or controlled by ATI, whether relating to the products sold or any other matter, except for the license expressly granted below.

In the course of supplying products and services hereunder, ATI may provide or disclose to Purchaser confidential and proprietary information of ATI relating to the design, operation, or other aspects of ATI's products. As between ATI and Purchaser, ownership of such information, including without limitation any computer software provided to Purchaser by ATI, shall remain in ATI and such information is licensed to Purchaser only for Purchaser's use in operating the products supplied by ATI hereunder in Purchaser's internal business operations.

Without ATI's prior written permission, Purchaser will not use such information for any other purpose of provide or otherwise make such information available to any third party. Purchaser agrees to take all reasonable precautions to prevent any unauthorized use or disclosure of such information.

Purchaser will not be liable hereunder with respect to disclosure or use of information which: (a) is in the public domain when received from ATI, (b) is thereafter published or otherwise enters the public domain through no fault of Purchaser, (c) is in Purchaser's possession prior to receipt from ATI, (d) is lawfully obtained by Purchaser from a third party entitled to disclose it, or (f) is required to be disclosed by judicial order or other governmental authority, provided that, with respect to such to maintain the confidentiality of such information.